

## INTEGRATED CARTRIDGE FOR EXTRACTING A BEVERAGE FROM A PARTICULATE SUBSTANCE

### Technical Field

The present invention relates to an integrated cartridge for extracting a beverage from a particulate substance, such as ground coffee, instant coffee, tea, powdered chocolate or milk, and the like.

### Background Art

It is known that machines for extracting a beverage from a particulate substance usually require that the particulate substance is placed into a filtering receptacle installed in the machine. In particular, automatic/semitomatic espresso coffee machines comprise a filtering receptacle, also called filter holder, in which a dose of ground coffee is placed before the extraction of coffee beverage takes place.

The general steps for extracting a coffee beverage in an espresso coffee machine, which are substantially equivalent to those of other automatic machines for preparing a beverage starting from a powdered substance, comprise a phase of delivering hot water under suitable pressure into an extraction chamber which includes the filtering receptacle, a brewing phase and a phase of conveying the brewed beverage into an external cup or glass, ready to drink.

Ground coffee, as well as other particulate substances for preparing brewed beverages, is usually a single use substance, in that the organoleptic qualities such as taste, aroma and body of the brewed beverage are irremediably lost once ground coffee has been soaked. Accordingly, in espresso coffee machines and in other brewing machines the particulate substance has to be removed after one single brewing. This is the reason why the filtering receptacle housing a dose of ground coffee is usually manually removable from the espresso coffee machine, in order to allow emptying of the receptacle from the used ground coffee and filling it with a new dose of ground coffee.

In order to facilitate the operations of filling and emptying the filtering receptacle, single serving pre-packaged tablets of ground coffee have been provided, consisting of a dose of ground coffee contained in a filtering paper bag or sachet, to be placed directly in a filter holder of the 5 espresso coffee machine. While this arrangement has resulted handy, it is affected by some drawbacks. In particular, the tablet is not air-tight and accordingly a second air-tight packaging must be provided for enclosing each dose, in order to keep the tablet uncontaminated from the external environment during storage.

10 Moreover, the user's hands come into contact with the tablet when the tablet is placed on the filter holder so that hygiene requirements are not fully assured.

15 In the past years, disposable capsules containing ground coffee have been also provided. Such capsules, generally having a frustum shape, are made of plastics or aluminum and provide a better air-tight barrier to the external environment than the filtering paper used in tablets.

A known capsule has a top surface that is pierceable by an injection needle/nozzle of the espresso coffee machine, in order to inject water under pressure inside the capsule, and a bottom surface comprising weakened 20 zones which tear under pressure of percolation fluids. An internal filter is also provided inside the capsule for preventing solid substances from being ejected from the capsule together with the coffee beverage.

Another known capsule comprises a cylindrical body made of polypropylene, with a top and a bottom surface having a plurality of 25 openings for distributing hot water throughout the dose of ground coffee, and comprising a sheet of paper filter for blocking passage of ground coffee outside the openings of the bottom surface during the extraction phase. These capsules have usually to be placed into a further packaging, such as a multilayered plastic sachet.

30 In order to prepare a coffee beverage, the known capsules and

cartridges are placed into the filter holder, that constitutes an extraction chamber for coffee when it is installed on the coffee machine. During the extraction phase, the percolation fluids may come into contact with internal surfaces of the extraction chamber before definitively flowing out into the 5 external coffee cup. Such contact contaminates the extraction chamber as well as the filter holder and after a number of coffee extraction operations the quality of the beverage is greatly reduced, suffering from residuals and contaminants in the extraction chamber.

Accordingly, the extraction assembly, comprising the extraction 10 chamber and the filter holder, has to be accurately cleaned after a certain number of coffee extraction operations; in addition, decalcification must be performed on a regular basis.

Even when such cleaning operations are regularly carried out, the fluid turbulence inside the extraction chamber of the machine or the 15 insufficient fluid-tight seal at the opened top surface of the capsule during water injection causes either the extracted beverage or the injected water to lap portions of the external surface of the capsule itself, thus jeopardizing the extraction hygiene requirements.

Another drawback of known capsules is that they do not retain 20 percolation fluid residuals inside the capsule, in that perforations or openings on the top surface and/or on the bottom surface of the capsules provide for an escape for fluid residuals when the extraction is terminated and/or when the capsule is removed from the machine, causing the capsule to drip and dirt the surroundings of the coffee machine.

In addition, the known capsules and espresso coffee machines do not 25 suffer from a limited hygienic character only, but they are often affected by a not so efficient distribution of hot water into the ground coffee and/or delivery of the coffee beverage.

In fact, in known capsules having a frustum shape, the hot water is 30 injected into the internal volume by means of a nozzle that pierces the top

surface, which has a smaller diameter than the bottom surface, so that hot water is sprayed from a single point rather than being evenly showered onto the whole dose of coffee. Accordingly, the hot water washes the coffee particles in an inhomogeneous way.

5        This drawback has been partially solved by the cartridge disclosed in EP-A-1344722, wherein two discs are provided inside the cartridge having a plurality of openings and a plurality of embossings, in order to create a plurality of fluid channels. Unfortunately, such known cartridge has to be pierced on both the upper and the lower surface in order to extract the  
10      beverage, and the internal volume of the cartridge has to be burdened with additional elements such as distribution discs.

15      Yet another drawback of prior art cartridges is that they are not very handy, in that a user must control the insertion direction when he installs the cartridge into an extraction machine. This control may be facilitated by means of a particular shape of the cartridge's receptacle in the machine, but when the user is particularly hurried (for instance, when the user is a barman assigned to continuously and quickly prepare coffee beverages for many customers) even a control of a minor nature is unacceptable.

#### Disclosure of the Invention

20      Aim of the present invention is to overcome the drawbacks of prior art cartridges and capsules by providing an integrated cartridge by means of which most of the tasks that are conventionally performed by beverage extraction machines are performed by the cartridge itself.

25      Within the scope of this aim, an object of the present invention is to provide a cartridge and an extraction assembly for producing a high quality beverage having improved organoleptic qualities, particularly when the beverage extraction machine is an espresso coffee machine.

30      A second particular object of the present invention is to provide a cartridge and an extraction system that greatly reduce or eliminate contamination of any component of machines for producing a beverage from

a particulate substance.

A further object of the present invention is to provide a universal beverage extraction system, which takes advantage of its contamination-free structure for allowing consecutive extractions of beverages from different  
5 kinds of particulate substances.

Another particular object of the present invention is to guarantee a high level of preservation of the particulate substance inside the cartridge until the cartridge is installed into the beverage extraction machine, reducing contamination of the particulate deriving from the external environment.

10 Another object is to simplify use of the cartridge, reducing the number of operations to be carried out for preparing the cartridge to installation into a beverage extraction machine.

15 A further object is to provide an improved even distribution of the injection fluid throughout the entire dose of particulate substance of the cartridge.

Yet another object is to simplify and reduce the internal load of the cartridge and the beverage extraction machine without affecting the quality of the final beverage.

Not least object of the invention is to provide a cartridge and an  
20 extraction assembly which speed up the beverage preparation operations.

This aim, these objects and other which will become apparent hereinafter are achieved by a cartridge for extracting a beverage from a particulate substance contained therein by means of water under pressure, the cartridge comprising: a main body comprising a cup portion and a lid  
25 portion, the cup portion comprising a base, a sidewall and a rim opposed to the base, the lid portion being fixedly attached to the rim of the cup portion so as to define an internal volume of the cartridge, the internal volume of the cartridge housing the particulate substance comprised within filtering means for retaining the particulate substance and for percolating fluid substances  
30 therethrough, the lid portion comprising a lid port defining a first passage for

percolation fluid substances, the base of the cup portion comprising a cup port defining a second passage for percolation fluid substances, characterized in that the base comprises a plurality of ridges directly formed thereon and protruding towards the internal volume of the cartridge, so as to  
5 support the filtering means and the particulate substance and to define a fine canalization between the filtering means and the cup port.

The aim and the objects of the invention are also reached by a cartridge for extracting a beverage from a particulate substance contained therein by means of water under pressure, the cartridge comprising: a main body comprising a cup portion and a lid portion, the cup portion comprising a base, a sidewall and a rim opposed to the base, the lid portion being fixedly attached to the rim of the cup portion so as to define an internal volume of the cartridge, the internal volume of the cartridge housing the particulate substance comprised within filtering means for retaining the particulate substance and for percolating fluid substances therethrough, the lid portion comprising a lid port defining a first passage for percolation fluid substances, the base of the cup portion comprising a cup port defining a second passage for percolation fluid substances, characterized in that it comprises a disc of porous material arranged between the filtering means and  
10 the base of the cup portion, so as to support the filtering means and the particulate substance and to define a fine canalization between the filtering means and the cup port.  
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15

The same aim and objects are also reached by a cartridge, particularly for espresso coffee machines, for extracting a beverage from a particulate substance contained therein by means of water under pressure, the cartridge comprising a main body comprising a cup portion and a lid portion, the cup portion comprising a base, a sidewall and a rim opposed to the base, the lid portion being fixedly attached to the rim of the cup portion so as to define an internal volume of the cartridge, the internal volume of the cartridge housing  
20 the particulate substance comprised within filtering means for retaining the  
25  
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particulate substance and for percolating fluid substances therethrough, the lid portion comprising a lid port defining a first passage for percolation fluid substances, the base of the cup portion comprising a cup port defining a second passage for percolation fluid substances, characterized in that the  
5 internal volume comprises valve means mounted on the cup port which are resiliently openable under pressure of the percolation fluid substances during a beverage extraction phase, so as to allow passage of the percolation fluid substances through the cup port during the beverage extraction phase.

Again, the objects of the invention are also achieved by a cartridge  
10 comprising a main body comprising a cup portion and a lid portion, the cup portion comprising a base, a sidewall and a rim opposed to the base, the lid portion being fixedly attached to the rim of the cup portion so as to define an internal volume of the cartridge, the internal volume of the cartridge housing the particulate substance comprised within filtering means for retaining the  
15 particulate substance and for percolating fluid substances therethrough, the lid portion comprising a normally closed lid port defining a first passage for percolation fluid substances when it is opened, characterized in that it comprises a tappet arranged inside the internal volume so as to pierce the base when a pressure is applied to the base towards the internal volume, thus  
20 opening a normally closed cup port.

#### Brief Description of the drawings

Further characteristics and advantages of the invention will become better apparent from the following description of preferred but not exclusive embodiments, illustrated by way of non-limitative embodiments in the  
25 accompanying drawings, wherein:

Figure 1 is a perspective view of a cartridge according to a first embodiment of the invention;

Figure 2 is a perspective, cross-sectional, exploded view of the cartridge of Figure 1, taken along plane A-A of Figure 1;

30 Figure 3 is a top view of the cup portion of the cartridge of Figure 1;

Figure 4 is a cross-sectional view of the cup portion of Figure 3, taken along plane B-B;

Figure 5 is a perspective cross-sectional view of a cartridge according to a second embodiment of the invention;

5 Figure 5 is a perspective cross-sectional view of a cartridge according to a second embodiment of the invention;

Figure 6 is a perspective cross-sectional view of a cartridge according to a third embodiment of the invention;

Figure 7 is a perspective broken away view of the shim of Figure 5;

10 Figure 8 is a perspective view of a cartridge according to a fourth embodiment of the invention;

Figure 9 is a perspective cross-sectional exploded view of the cartridge of Figure 8;

15 Figure 10 is a perspective cross-sectional view of a cartridge according to a fifth embodiment of the invention;

Figure 11 is a perspective view of the inner side of the lid portion of the cartridge of Figure 10;

Figure 12 is a perspective view of a cartridge according to a seventh embodiment of the invention;

20 Figure 13 is a perspective cross-sectional view of the cartridge of Figure 12, taken along a radial plane;

Figure 14 is a perspective cross-sectional view, taken along a radial plane, of the cartridge according to the seventh embodiment of the invention in a pierced state;

25 Figure 15 is a perspective view of the tappet assembly housed in the cartridge of Figure 12;

Figure 16 is a perspective view of an extraction assembly according to a second aspect of the invention;

30 Figure 17 is an exploded view of the extraction assembly of Figure 16;

Figure 18 is a perspective broken away view of the extraction assembly of Figure 16 arranged in the beverage extraction position, having a cartridge installed therein;

5 Figure 19 is a perspective broken away view of an extraction assembly arranged in the beverage extraction position, having a discoidal cartridge installed therein;

Figure 20 is a perspective broken away view of the extraction assembly of Figure 16 arranged in the cartridge expulsion position;

10 Figure 21 is a bottom view of the nozzle used in the extraction assembly of Figure 16;

Figure 22 is a partial cross-sectional lateral view of the nozzle used in the extraction assembly of Figure 16;

Figure 23 is a cross-sectional lateral view of the nozzle used in the extraction assembly of Figure 19;

15 Figure 24 is a broken away view of an extraction assembly according to a further embodiment of the invention, in which the capsule of Figure 12 is installed;

Figure 25 is a broken away view of the extraction assembly of Figure 24 when it is arranged in the beverage extraction position;

20 Figure 26 is a side cross-sectional view of the injection nozzle used in the extraction assembly of Figure 24;

Figure 27 is a perspective cross-sectional view, taken along a radial plane, of the cartridge according to a further embodiment of the invention;

25 Figure 28 is a broken away view of an extraction assembly according to a further embodiment of the invention, in which the cartridge of Figure 27 is installed.

#### Ways to carrying out the Invention

With reference to Figures 1 and 2, a cartridge **1** is shown according to a first preferred embodiment of the present invention. The cartridge has a generally cylindrical shape and comprises a cup portion **2** and a lid portion **3**

fixed thereon.

In particular, the cup portion 2 comprises a substantially circular base 7, a cylindrical sidewall 8 extending from base 7 and a rim 9a, which is disposed substantially opposite to the base 7 and defines an open end of the 5 cup portion 2.

An internal volume is defined by the cup base 7, the sidewall 8 and the lid portion 3, when the lid portion is fixed on the cup portion. A dose of ground coffee 4 is housed in such internal volume and it is sandwiched between filtering means, preferably consisting of a first paper or tissue filter 10 5b and a second paper or tissue filter 5a. In an alternative embodiment, a tablet of a known kind can be provided, as it will be described hereafter.

The cup portion 2 comprises a cup port 6a, which is preferably located in a central region of the cup base 7 and protrudes outwardly with respect to the internal volume of the cartridge, forming a spout. As shown in 15 Figure 2, the cup port 6a has a substantially cylindrical shape and provides for open access to the internal volume of the cartridge, thus allowing passage of fluids to or from the internal volume of the cartridge. To this aim, the opening 103a is provided on the cup base 7 in correspondence of the cup port 6a, as it is shown in Figure 4.

20 The cup base 7 optionally comprises a flange 105a, axially aligned with sidewall 8 and protruding outwardly with respect to the internal volume of the cartridge. Such flange is preferably provided in order to end up with a protruding shape facilitating and promoting handling and automated production processes. Furthermore the capsule can be placed in a horizontal 25 position on a table surface without tilting or rolling, it can be packaged and stacked more easily and it can also be "strip" packaged, i.e. fixed and sealed between two strips of polylaminate films..

The lid portion 3 is shaped so as to fit with the open end of the cup portion 2 and comprises a lid base 7b, from which a substantially cylindrical 30 sidewall 105b extends upwardly and slightly outwardly and which is

substantially perpendicular to the lid base 7b. The sidewall 105b ends with an annular edge 9b that is located substantially opposite to the lid base 7b and that protrudes outwardly from the sidewall 105b, in order to fit with and lean on the rim 9a of the cup portion 2. Preferably, the annular edge 9b has a 5 substantially stepped cross section, so as to engage with a complementary support located at the rim 9a of the cup portion 2, as depicted in Figure 3. Other cross-sectional shapes of the annular edge 9b and of the rim 9a can be alternatively provided, as long as these shapes allow to fix the lid portion on the cup portion.

10 In preferred embodiments, the lid portion and the cup portion are welded to each other using an ultrasonic shear-welding technique. Alternatively, other known welding techniques can be used, for instance common ultrasonic welding, hot welding, bonding and so on. The cartridge according to the invention may also be manufactured as a single moulded 15 piece.

The protruding sidewall 105b is preferably provided in order to facilitate and promote handling and automated production processes, as well as to dissociate the shear welding region away from the coffee tablet, thus minimizing interferences of migrating coffee particles with the plastic weld, 20 which might compromise its tight sealing characteristics.

In the preferred embodiment depicted in Figures 1 and 2, the lid portion 3 comprises a lid port 6b in a central region of its base 7b, having a generally cylindrical shape and protruding from base 7b outwardly with respect to the internal volume of the cartridge. The lid port 6b provides for 25 open access to the internal volume of the cartridge, thus allowing passage of fluids to or from the internal volume. To this aim, the opening 103b is provided on the lid base 7b in correspondence of the lid port 6b, as shown in Figure 2.

It is seen that flanges 105a and 105b, together with the 30 corresponding cup port and lid port, are such that the top and the bottom

regions of the cartridge substantially have an overall E-shaped cross-section.

In alternative embodiments, described hereafter, the lid port does not protrude from the lid base **7b** or is normally closed, being pierceable by an injection needle or nozzle during the extraction phase. Alternative 5 embodiments of a similar kind will be presented hereafter.

In the cartridges according to the invention, either the lid port **6b** or the cup port **6a** may comprise hurdles for deviating a fluid flow. In particular, referring back to the embodiment of Figures 2-4, a first barrier **104a** is provided on the internal side of the cup base **7** so that it radially 10 crosses the central opening **103a** from which the spout **6a** protrudes, and second barriers **106a**, **107a** are provided on the internal surface of the cup port **6a** at a distance from the first barrier and from the opening **103a**.

Preferably, second barriers **106a** and **107a** face each other and protrude from the internal surface of the cup port **6a** so as to define a sort of 15 zigzag path for the fluid passing through the cup port **6a**, thus breaking any direct fluid flow to or from the internal volume of the cartridge and avoiding exceedingly accelerated fluid flow, which may cause jet-spray effects such as spattering.

The first barrier **104a** is particularly useful for either deviating the 20 fluid flow or providing a support against filter paper deformation that may result from the hydraulic extraction fluid pressure. Accordingly, obstruction of the openings **103a** and possible breaking of the filter paper are prevented.

Additionally or alternatively, corresponding fluid flow barriers **104b** and **107b** are also provided at lid port **6b**, as seen in Figure 2. In particular, 25 the barrier **104b** spans the lid opening **103b**, while the barrier **107b** protrudes from the internal surface of the lid port **6b**, facing an identical barrier in order to define a fluid flow pathway substantially analogous to that formed inside the cup port **6a**.

Notwithstanding preferred embodiments of the cartridge according to 30 the invention comprise fluid flow hurdles as depicted in Figures 2-4, the

skilled in the art easily appreciates that alternative arrangements or shapes of fluid flow hurdles can be used for the same purpose. For instance, a cross-shaped fluid flow barrier may be provided, so as to support the paper filter and break direct fluid flow into four separate flows. Alternatively, radial 5 projections formed around the lid or the cup opening and radially protruding towards the center of such opening may be provided, as it will be described hereinafter with reference to Figure 27.

Fluid flow hurdles may not be directly formed on the internal surface of the cartridge, but they may be a separate means which can be inserted and 10 fixedly attached to an inlet or an outlet port of the cartridge. For instance, a small plastic tube with both open ends closed by a fluid permeable filter material (for instance, films of thermoplastic sieve material or open mazed tissue or paper). An example of a separate fluid flow hurdle will be described hereinafter with reference to Figure 27.

15 Moreover, the fluid flow hurdles may be provided at both the lid and cup ports, at only one of such ports, or may not be provided at all, according to fluid flow requirements.

The cup portion **6a** further comprises a plurality of ridges **101a** directly formed on the base **7** and protruding towards the internal volume of 20 the cartridge, in particular towards the external surface of the paper filter **5a**. As it is seen from Figure 3, the ridges **101a** are arc-shaped and elongated. They directly contact paper filter **5a** so as to form a plurality of small channels **102a-102b**, which are directed along a plurality of concentric and radial directions (as shown in Figure 3) and put in a fluid communication the 25 whole bottom surface of the filter-coffee assembly **4, 5a** with the cup port **6a**. Such channels, preferably, have an average width/height of about 1mm.

Similarly, ridges **101b** are provided on the lid portion **3** which protrude towards the internal volume of the cartridge, in particular towards the upper surface of the paper filter **5b**. A plurality of small channels is 30 accordingly provided between the filter **5b** and the lid base **7b**, connecting

the lid port **6b** to the whole top surface of the filter-coffee assembly **4, 5b**.

In alternative embodiments, small fluid channels may be provided on cup portion only, or on lid portion only, or they may not be provided at all. In such cases, a reduced number of ridges is preferably formed on either the 5 cup base or the lid base, and they protrude towards the internal volume of the cartridge in order to form an air space between the cup/lid base and the filtering means. An exemplary arrangement of such kind will be explained hereafter with reference to Figure 11.

Alternatively, in order to provide a fine canalization on at least a 10 portion of the internal surface of the cartridge facing one of the top surface or the bottom surface of the dose comprising the ground coffee and the filtering means, a disc of porous material may be arranged between such dose and the cup port or the lid port. Preferably, such disc extends throughout the top or the bottom surface of the dose.

15 Even though not explicitly shown in Figures 1-4, the lid port and/or the cup port are preferably plugged by a film, for instance made of multilayered plastics, which can be manually removed or can be pierced or torn by the machine during the extraction phase.

Alternatively, the lid port or the cup port may be plugged by an 20 integrated surface created during the manufacturing of the lid portion or by a rubber plug or seal, to be described thereafter, or the entire cartridge may be kept in a sachet or packaging to be manually opened before use. The sachet or packaging may be made of a polylaminate vacuumed or filled with an inert gas under pressure (such as in Modified Atmosphere Packaging or 25 MAP techniques).

Either the lid port or the cup port may be alternatively sealed by means of edible solid substances (e.g. polysaccharides, proteins and lipids) that are air-impermeable and water-soluble or that melt at the temperature of the inlet water.

30 The cartridge **1** is preferably made of polypropylene and it is

manufactured using known injection moulding techniques. Anyway, this cartridge as well as any cartridge according to the invention may be made of any material such as: other thermoplastic materials, for instance PET; elastomeric-thermoplastic materials or TPEs, for instance, SANTOPRENE,  
5 i.e. a mixture of non interlaced EPDM and polypropylene; thermosetting compositions, for instance, a polyester; rubbers or elastomers, for instance, silicone or MVQ; polylaminate thermoplastic materials, for instance a composite sheet made of PE, PET and PVDC; aluminium; other polylaminate materials, for instance, a composite sheet made of PE, PET and  
10 aluminium. The cartridge **1** may also be manufactured using other techniques, such as thermoforming.

The main body of an exemplary cartridge such as the one depicted in figure 1 is, for instance, 30-35mm high and 35-40mm wide, and the lid port and the cup port are about 7-8mm high and 8-10mm wide. However, the  
15 skilled in the art readily understands that the size of the cartridges according to the invention may be different, according to the extraction requirements and the structure of the beverage extraction machine.

Having now defined the main characteristics of cartridge **1**, it can be appreciated that this cartridge eliminates the traditional contamination of the  
20 extraction chamber of a coffee machine, in that the cup port/spout **6a** acts as an outlet for directing the extracted beverage directly into an external cup that is then used for drinking. The spout **6a** is accordingly shaped so as to fit in known filter holders or so as to outwardly protrude with respect to purpose-built filter holders, thus keeping perfectly clean the internal surfaces  
25 of the filter holder and prevent the extracted beverage exiting the cartridge from contacting such surfaces.

Additionally, the small channels directly formed on the internal surface of the cup portion allow to eliminate additional fluid director members from the inside of the cartridge and advantageously combine with  
30 the cup port so as to define an integrated conveyor for the extracted

beverage. At the same time, the small channels allow to keep the internal pressure level drop of the cartridge at a substantially lower value between upper zone and lower zone of the coffee cake, so that the full volume of ground coffee is exploited and the resulting beverage has enhanced 5 organoleptic qualities.

For functional reasons, it is preferable to keep the space between the coffee cake and base of the cup portion or the lid portion as little as possible.

Another improvement involved by the particular cartridge of Figure 1 is that it is reversible, i.e. it can be inserted also upside-down. In fact, the 10 main body of the cartridge is shaped so as to be substantially symmetrical with respect to a virtual plane perpendicular to the water injection axis. In particular, the cup port **6a** and the lid port **6b** are substantially identical in shape and size, they are aligned on a same water injection axis and the height of flange **105a** is substantially equal to the height of the cylindrical sidewall 15 **105b**, as illustrated in Figure 2. Advantageously, a fine canalization is provided on both the internal surfaces of the cup portion and of the lid portion.

Accordingly, the cartridge **1** can be installed in a filtering receptacle regardless of which port will act as the inlet port and which port will act as 20 the outlet port, thus greatly facilitating the operation of inserting the cartridge into an extraction machine.

While characteristics have been shown with reference to the exemplary embodiment of Figures 1-4, several alternative embodiments of the invention can be provided by either suitably combining the fundamental 25 characteristics already illustrated or by adding other features still falling within the scope of the invention.

With reference to Figure 5, a second preferred embodiment of the invention is illustrated. In particular, Figure 5 is a cross-sectional view of a cartridge **11** which, even though the main body is externally similar to that 30 depicted in Figure 1, features internal variants.

While only a sectional view of cartridge **11** is shown in Figure 5, it is understood that this view is taken along a virtual radial plane halving the whole actual cartridge, which is not shown in the Figures for clarity reasons. It is clear that the skilled in the art has no difficulty in picturing the structure 5 of the whole cartridge **11** starting from the sectional view of Figure 5.

The cartridge **11** has a generally cylindrical shape and comprises a cup portion **12** and a lid portion **13**. The cup portion **12** comprises a base **17**, a sidewall **18** and a rim **19a** that is disposed substantially opposite to the base **17** and defines an open end of the cup portion **12**.

10 An internal volume is defined by the cup base **17**, the sidewall **18** and the lid portion **13**, when the lid portion is mounted on the open end of the cup portion **12**. A dose of ground coffee is housed in such internal volume, enclosed by filtering means either in a way similar to that depicted in Figure 2 or as in a tablet or cake of a known kind, as it will be better described 15 hereafter.

In Figure 5, both the ground coffee and the filtering means have been omitted for simplicity, but it is intended that they substantially fill the internal volume of the cartridge, as it occurs in the embodiment of Figure 2.

20 The cup portion **12** comprises a cup port **16a**, preferably located in a central region of the cup base **17** and protruding outwardly with respect to the internal volume of the cartridge. The cup port **16a** has a substantially cylindrical shape and provides for open access to the internal volume of the cartridge, thus allowing passage of fluids to or from the internal volume of the cartridge. To this aim, an opening **113a** is provided on the cup base **17** in 25 correspondence of the cup port **16a**.

The cup base **17** preferably comprises a flange **115a**, aligned with the sidewall **18** and protruding outwardly with respect to the internal volume of the cartridge.

30 The lid portion **13** is shaped so as to fit with the open end of the cup portion **12** and comprises a lid base **17b**, from which a substantially

cylindrical sidewall **115b** extends upwardly and slightly outwardly. The sidewall **115b** ends with an annular edge **19b** that is located substantially opposite to lid base **17b** and that protrudes outwardly from the sidewall **115b**, in order to fit with and lean on rim **19a** of the cup portion **12**.

5 Preferably, the annular edge **19b** has a substantially stepped cross section, so as to engage with a complementary support located at the rim **19a** of the cup portion **12**, as depicted in Figure 5. Alternatively, other cross-sectional shapes of the annular edge **19b** and of the rim **19a** can be provided, as long as such shapes allow to fix the lid portion on the cup portion.

10 The lid portion **13** further comprises a normally closed lid port **16b**, preferably located in a central region of the base **17b** and protruding outwardly with respect to the internal volume of the cartridge **11**. The wording "normally closed" as intended herein indicates a port which is air-tight sealed before extraction and it is opened either manually by a user or  
15 automatically by the beverage extraction machine, for example by piercing the surface that plugs the port.

20 In the embodiment of Figure 5, the lid port **16b** is plugged by a weakened small surface **14** that is integrated with the lid port **16b**. Alternatively, the lid port may be plugged by a plastic film welded on the external mouth of the lid port or by a rubber or rubber-like plug or seal, described hereafter.

The internal surface of the lid port **16b** is substantially smooth, but fluid flow hurdles can be alternatively provided as those described with reference to the embodiment of Figure 2.

25 The cup portion **12** comprises a cup port **16a**, located on the cup base **17** and preferably having a substantially cylindrical shape. In the preferred embodiment depicted in Figure 5, the cup port **16a** is located in the central region of the base **17**, protrudes outwardly with respect to the internal volume of the cartridge **11** and comprises hurdles **114**, **117a** and **117b** for  
30 breaking direct fluid flow passing through the cup port.

The first hurdle **114** is formed inside the cup port **16a** in the proximity of its output mouth so as to radially cross the internal volume of the cup port, while the second hurdles **117a** and **117b** flange out the internal surface of the cup port and face each other.

5         Similarly to the embodiment depicted in Figure 2, the cup portion **12** comprises a plurality of ridges **111a** that are directly formed on the internal side of the base **17** and protrude towards the internal volume of the cartridge. The ridges **111a** define a plurality of small channels **112a**, **112b** between the cup base **17** and the filtering means, for conveying the extracted beverage to  
10         the cup port **16a**.

In the particular embodiment shown in Figure 5, unlike lid portion **3**, a fine canalisation is not provided between the lid portion and the assembly consisting of the ground coffee and the filtering means. Instead, sparse ridges **111b** are provided on the bottom side of the lid portion **13**, serving the  
15         purpose of creating a very small gap between the lid portion and the ground coffee. However, it is clear that as an alternative to this arrangement a canalisation may still be provided, as described above with reference to the lid portion **3**.

Advantageously, the cartridge **11** comprises valve means, for  
20         regulating the fluid flow passage through the cup port **16a**. The valve means are particularly conceived for application to the cup port, but they can be applied to both the cup port and the lid port of a cartridge according to the invention, or to the lid port only, according to the functional requirements of the cartridge.

25         In the embodiment shown in Figure 5, the valve means lean on an annular recess **15**, that is formed around the opening **113a** and cover opening **113a**. To this aim, the thickness of the base **17** preferably tapers from the cup port **16a** towards the periphery, to allow the formation of the recess **15**.

The valve means preferably comprises a rubber (e.g. silicone rubber),  
30         rubber-like, elastomeric or plastic pad or disc having a narrow through slit or

orifice formed therein connecting a top surface to a bottom surface of the pad. If no axial pressure is applied to the pad, the slit provides for an air-tight seal, whereas if an axial pressure is applied, such as the pressure of percolation fluids extracted from the ground coffee, a portion of the pad  
5 warps and the slit slightly widens, thus allowing passage of the percolation fluids, i.e. of the beverage.

According to the particular embodiment depicted in Figure 5, the valve means comprise a rubber pad or disc **116**, leaning on the recess **15** so as to air-tightly close the aperture **113a** of the cup port and acting as a  
10 septum. While the pad **116** is described as simply leaning on the recess **15**, it may optionally be bonded to such recess or otherwise fixed using known techniques.

The pad **116** comprises a top circular surface and a bottom circular surface and a slit **118** that axially traverses the pad from the centre of the top  
15 surface to the centre of the bottom surface.

The slit **118** is a pre-pierced one and it is preferably made using a thin needle. The slit may alternatively be a radial linear or cross-shaped cut or incision, or a plurality of slits may be provided through the pad, as long as these slits, cuts or incisions do not substantially allow passage of air inside  
20 the cartridge when the cartridge is not under fluid pressure and allow passage of percolation fluids during the beverage extraction phase.

In order to provide a support for the filtering means enclosing the ground coffee and to convey the extracted beverage to the pad **116**, a shim **119** is advantageously mounted on the cup base **17** and upstream of the pad  
25 **116**.

With particular reference to the broken away view of Figure 7, the shim **119** comprises a bottom surface that faces the pad **116** and that is shaped so as to define fluid flow channels **319** between the shim and the pad: to this aim, the bottom surface of the shim **119** comprises radially oriented  
30 ridges **219**.

The top surface of the shim **119** comprises ribs for supporting the coffee-filtering means assembly, which are preferably sized so that the thickness of the shim **119** is substantially equal to the height of the ridges **111a** of the cup portion **12**.

5 In alternative embodiments, not shown in the Figures, the shim may comprise through holes for conveying the percolation fluids to the rubber pad, or it may be substituted by any other supporting means that separate the dose of ground coffee from the rubber pad, such as those depicted in Figure 27 to be described hereinafter.

10 Yet in another embodiment, the valve means do not comprise a separate shim at all. For instance, a third embodiment of the invention comprising such alternative valve means comprises only a pad or disc, made of rubber, rubber-like, elastomeric, or whichever resilient material.

15 In particular, with reference to Figure 6, a cartridge **21** according to a third preferred embodiment of the invention comprises a cylindrically shaped cup portion **22**, comprising a base **27**, a sidewall **28** and an open end on which a lid portion **23** is engaged so as to define an internal volume of the cartridge. Inside the cartridge, a dose of ground coffee and the corresponding filtering means are provided as in the previously described cartridges, but 20 they are not shown in Figure 6, for simplicity.

The lid portion **23** comprises a normally closed lid port **26b** and it has substantially the same features of the already described lid portion **13**.

25 The cup portion **22** comprises a cup port **26a**, inside which fluid flow hurdles **124**, **127a** and **127b** are provided. Moreover, the top surface of the base **27** comprises a plurality of ridges **121**, which are arc-shaped and distributed throughout the surface of the base **27** substantially as ridges **111a**, so as to define concentric and radial small channels which converge to an annular recess **25**. A circular rubber pad **126** leans on the recess **25** so as to air-tightly plug the aperture **123a** of the cup port **26a**. Notwithstanding 30 pad **126** is herein described as simply leaning on recess **25**, it may optionally

be bonded to an edge of such recess or be otherwise fixed through known means.

Similarly to pad **116**, pad **126** comprises a through slit **128** at its centre, which slit is normally closed and slightly widens, thus allowing 5 passage of the percolation fluids, during the beverage extraction phase.

In order to support the dose of ground coffee and the filtering means, the pad **126** preferably comprises ribs **129**, which are directly formed on its top surface and shaped so as to allow the passage of fluids directly deriving from the coffee/filter assembly and from the channels defined by ridges **121**.

10 Pads **116** and **126** have been described as being made of rubber, elastomeric or other flexible materials. The elastic properties of such materials allow a pre-pierced orifice or channel such as the slit **118** or the slit **128** to act as an air-tight seal, but at the same time allow to readily respond to pressure stresses directed either towards or from the internal volume of the 15 cartridge. In other words, such pads act as valves or baffles.

Therefore, a cartridge comprising such pads requires no means for plugging the cup port - or the lid port, if the pad is applied to the lid port in a way similar to that described above -, such as films or pierceable diaphragms. At the same time, after the extraction phase has terminated, the 20 sudden fall of internal pressure causes the slit to return in the initial rest condition, thus preventing possible internal fluid residuals to drip out of the cartridge.

Beyond its valve-like functioning that protects the cartridge from negative environment influences, at the same time permitting degassing of 25 the cartridge and the extraction fluid to drop after extraction, the above described pad also allows the insertion of liquid inert gas from the outside by means of a hollow needle during the packaging phase (MAP), in order to condition the capsule and prepare it for longer storage periods. The rubber pad then closes automatically by its own elasticity after the needle for 30 inserting the gas has been pulled out. The same needle may be the one that

pierces the pad so as to form the slit referred to above.

At the same time, another important advantage brought by the pads according to the invention is the great improvement in the forming and stability of the appreciated cream layer on top of the extraction beverage,  
5 which is usually identified with the Italian term "crema" when referred to espresso coffee extraction methods.

The espresso extraction method results in a polyphasic beverage constituted by a foam layer of small bubbles with dispersed fine particles that create the typical and particular tiger-tail pattern on top of an emulsion of  
10 microscopic oil droplets in an aqueous multi-component solution with dispersed gas bubbles and solid particles.

The foam formation is related to surfactants naturally present in coffee and to a number of phenomena which are triggered by espresso extraction methods.

15 The supernatant foam of espresso coffee or crema is an extremely important organoleptic characteristic and represents a mark of distinction between espresso coffee and other preparations.

It is well known that the foam characteristics are the signature of a perfect preparation, being any error (for instance in coffee grinding, water  
20 temperature, water pressure, percolation time and/or beverage volume, etc) or any change (coffee blend, roasting, etc.) immediately denounced by the colour, the texture and the persistence of espresso foam.

As described above, the valve means according to the preferred embodiment of the invention comprise at least a rubber or rubber-like pad or  
25 disc having a through slit whose diameter is very small, e.g. in the order of 0,1 to 0,5 mm when it is opened. Forcing the extracted coffee through it has been found to greatly increase the density and the stability of the crema. This effect is a very advantageous one since, through the integration of a means of a relatively light weight and of simple nature, it is possible to achieve an  
30 important effect that characterizes the quality of an espresso coffee beverage.

Moreover, since the rubber pad for crema formation is integrated with the cartridge, which is generally a disposable one, it is guaranteed that the extracted espresso coffee has a layer of crema of the best quality, contrary to the known espresso coffee machines in which the devices that 5 enhance the formation of crema are part of the machines, they are used for a great number of extraction processes and may deteriorate the quality of the extracted coffee over time.

Cartridges according to the invention are not to be limited to the substantially cylindrical cartridges described here above. Particularly, the 10 term "cylinder" has to be read in a broad general meaning and indicates the surface traced by any line moving parallel to a fixed axis and intercepting a closed line. For instance, the main body of the cartridge according to particular embodiments of the invention can be either parallelepiped-shaped or discoid-shaped, too. Furthermore, the term "substantially cylindrical" also 15 indicates cylindrical cartridges having a slight frustum shape, that is to say, for instance, the slope of the sidewall of a cartridge according to the invention can deviate for 1-2 degrees from a perfect cylindrical surface.

A parallelepiped-shaped cartridge, not shown in the Figures, is particularly a preferred one when small space occupancy is required.

20 A discoid-shaped cartridge, instead, can be advantageously provided in the alternative for other reasons, which will be now explained. An exemplary embodiment of the invention in which the main body of the cartridge is substantially discoid-shaped is depicted in Figures 8 and 9. A cartridge 31 of this kind embodies some of the features of the above 25 cartridges, in particular it comprises a cup portion 32 and a lid portion 33, both of them having substantially the shape of a dish.

The cup portion 32 comprises a base 37, an annular sidewall and a flanged rim 39a that is directed substantially parallel to the base 37 and, similarly, the lid portion 33 comprises a base, a sidewall and a flanged rim 30 39b that is shaped so as to engage with the rim 39a, thus defining an internal

volume of the cartridge. The internal volume of the cartridge is shaped so as to fully house a ground coffee tablet or cake **34** of a known kind, such as the tablet called E.S.E.®.

Such known tablet comprises a dose of ground coffee encapsulated 5 within a filter paper sachet, whose peripheral edge is tightly retained by rims **39a** and **39b** when the cartridge **31** is in the assembled condition. Rims **39a** and **39b** may be reciprocally fixed using any known method such as ultrasonic welding, hot element welding, or other welding techniques, gluing or combinations of these with common border forging or deforming 10 methods.

The cup portion **32** further comprises a substantially cylindrical cup port **36a** protruding outwardly with respect to the internal volume of the cartridge **31**, which is advantageously provided with inside hurdles **137a** and **134a** for breaking direct fluid flows passing through the cup port, which are 15 similar to the above described hurdles **117a**, **117b**, **114**.

The base **37** comprises a plurality of ridges **131** distributed on its planar inner side, which define a plurality of small channels between the tablet **34** and the base **37**. The ridges **131** surround a central annular recess **35**, similar to the above described recesses **15** and **25**, on which a rubber pad 20 **136** leans.

The pad **136** has a through, normally closed slit at its centre and supporting ribs on its top surface for supporting the tablet **34** and allowing fluid passage there-between. It is seen that the pad **136** is similar to the above described pad **126**.

25 A lid port **36b** protrudes from the central region of the lid portion **33** and comprises reciprocally facing hurdles **137b** on its internal surface.

Figure 9 is a cross-sectional view of cartridge **31** and, as such, shows only one hurdle **137b**, but it is understood that an identical hurdle is present on the opposite side of the internal surface of the lid port that faces the 30 depicted one. Moreover, the opening from which the lid port **36b** protrudes

out is bridged by a fluid flow barrier **134b**, that is substantially analogous to the above described barrier **104b**.

The lid port **36b** is plugged by a film of aluminium or polylaminate plastics **38**, that forms an air-tight seal for the lid port before installing the 5 cartridge into an espresso coffee machine. The film **38** is preferably pierceable by the injection needle of the machine, but a manually removable film may be provided in the alternative.

As in the cartridges depicted in Figures 5 and 6, the lid portion **33** comprises sparse ridges on the surface directed towards the internal volume, 10 which define a very small gap between the coffee tablet **34** and the lid portion itself.

The cartridge **31** is particularly advantageous in that it is fully compatible with existing coffee tablets. The manufacturing process of this cartridge is also sped up, since no further filtering means have to be inserted 15 into the cartridge.

Moreover, it is seen that the cartridge **31**, as well as the other cartridges described above, is an all-in-one cartridge, that is to say a cartridge in which most of functional features of standard espresso coffee machine, such as filtering, water distribution, crema enhancement and 20 beverage delivery are integrated into the cartridge itself. The espresso coffee machine functions are mainly to support the cartridge and to inject water under pressure inside it.

Figure 10 is a cross-sectional view of a cartridge **41** according to yet another embodiment of the present invention. This cartridge comprises most 25 of the features of cartridge **1**, that is to say a cylindrical cup portion **42** whose base **47** comprises a plurality of ridges **141a** and a spout **46a** with fluid flow hurdles **144** and **147**, a dose of ground coffee **4** and filter paper sheets **5a** and **5b**. An aluminium or multilayered plastics film **45** plugs the external mouth of the spout **46a** and it is manually removable.

30 Differently from the embodiment of cartridge **1**, the lid portion **43**

having a substantially flat shape is provided, comprising a lid port **46b** which only slightly protrudes from the plane of the lid portion and an annular edge **49b** that slightly protrudes from the contour of the lid portion.

With reference to Figures 10 and 11, the inner side of the lid portion 5 **43** comprises sparse radial ridges **141b** that slightly protrude towards the internal volume of the cartridge, so as to create a small gap between the upper filtering means **5b** and the lid portion **43**.

Moreover, the lid portion **43** comprises a rubber/rubber-like plug or seal **48** that engages the mouth defined by the lid port **46b**. The plug **48** is 10 preferably made of a thermoplastic elastomer (TPE) such as EPR or SBS and has a central thinner portion that is pierceable, for instance by an injection needle or a nozzle of the espresso coffee machine, and has a thicker portion surrounding such central portion that grips the mouth of the lid port **46b**.

The thicker and central portions of the plug **48** are sized so as to 15 sealingly engage with the tube or nozzle that delivers water to the cartridge. In other words, the plug **48** acts as a radial fluid-tight seal for the injection tube or nozzle, thus preventing the injected water to splash out of the lid port **46b** during the beverage extraction phase.

As the extraction phase is terminated and the cartridge **41** is 20 separated from the injection nozzle, the plug **48** elastically returns to a rest position due to its resilient nature and, even though it has been pierced, it is a good retainer for solid and fluid residuals, which are kept inside the cartridge as soon as it is removed from the machine.

While the plug **48** has been illustrated inside the cartridge **41**, it is 25 understood that such plug can be applied to any other cartridge according to the invention, such as to the cartridges previously described.

Figure 27 depicts a cartridge **81** according to a further embodiment of the invention. This cartridge comprises features substantially corresponding to those of cartridge **21**, that is to say a cylindrical cup portion **82a** whose 30 base **87a** comprises a plurality of ridges **181** and channels **182** directly

formed thereon and an externally protruding cup port **86a**, a lid portion **83a** being fixedly attached to the upper rim of the cup portion **82a** so as to define an internal volume in which a cake of ground coffee and filtering means (not shown) are housed.

5        The lid portion **83a** comprises a base **87b**, on which sparse ridges are formed similar to ridges **111b**, and comprises a normally closed lid port **86b**, which is preferably located in a central region of the base **87b** and protrudes outwardly with respect to the internal volume of the cartridge **81**. The lid port **86b** is plugged by an aluminium or polylaminated plastics film.

10      The internal surface of the lid port **86b** is substantially smooth and a cross-shaped fluid flow hurdle **89** quarters the opening **183b** from which the lid port **86b** protrudes. The hurdle **89** preferably protrudes towards the internal volume of the cartridge, so that the filtering means that covers the cake of particulate substance is kept at a distance away from the base **87b** of  
15      the lid portion **83a**.

10      The diameter of the lid port **86b** is generally wider than the ones of the other lid ports described above, in order to completely receive a water injection nozzle without the need of using a needle for accessing the internal volume of the cartridge. The internal diameter of the lid port is preferably at  
20      least 5mm wide, but such diameter may be even wider, e.g. it may be substantially equal to the diameter of the lid base **87b**.

10      The ridges **181** of base **87a** surround a central annular recess **85a** formed around the opening **183a** from which the cup port **86a** protrudes. The ridges that closely surround the opening **183a** comprise projections **184** that  
25      radially extend towards the center of the opening **183a** and that are as thick as the ridges **181** themselves. The projections **184** act both as a support for the cake of particulate substance and the filtering means and as a fluid flow hurdle for breaking direct fluid flow.

10      The cartridge **81** further comprises a rubber pad **186**, which is  
30      installed between the projections **184** and the annular recess **85a** and which

comprises a central through slit. The rubber pad **186** is a valve means as intended above.

The cup port **86a** advantageously comprises a fluid flow hurdle **187**, which is a separate piece that is inserted into the cup port and is tightly engaged with the internal surface of the cup port. Providing a separate fluid flow hurdle and eliminating the hurdles directly formed on the internal surface of a port is an advantageous arrangement that is particularly suited for the so-called sequential moulding manufacturing techniques.

The “separate” hurdle **187** preferably comprises a small plastic hollow tube **188** whose open ends are closed with a fluid permissive filter material, for instance a film of plastic sieve material or open mazed tissue/paper. Alternatively, internal barriers can be formed on the internal surface of the tube **188**, which are substantially similar to barriers **114**, **117a** and **117b** described above.

In the embodiment depicted in Figure 27, the tube **188** comprises an upper sieve film **185b** and a bottom sieve film **185a**. In order to fix the hurdle **187** to the inner surface of cup port **86a**, the tube **188** comprises an annular rib **189a** on its outer sidewall for snap-fitting with a corresponding annular recess **189b** formed around the inner surface of the cup port **86a**. Obviously, many other arrangements for fixing a separate hurdle means to the cup port or the lid port are clearly in the reach of the skilled in the art.

With reference to Figures 12-15, a cartridge or capsule **51** according to a further embodiment of the invention comprises a cup portion **52** having a closed base **57** and a peripheral flange **59a** on its mouth. A substantially flat lid portion **53** is fixedly attached to the cup portion **52**, for instance by axially hot welding the peripheral edge **59b** of the lid portion **53** to the flange **59a**. Obviously, any other known joining technique can be provided in the alternative for fixedly attaching the lid portion to the cup portion, such as ultrasonic welding, bonding or combinations of these with forging or deforming techniques.

The lid portion **53** comprises a normally closed lid port **56b** having an M-like cross section and further comprises bulges **151a** and **151b**, for creating a small gap between the lid portion and a dose of ground coffee **54** filling the capsule **51** and sandwiched between filtering means, such as filter paper sheets.

The base **57** and the dose of ground coffee form a substantially conical hollow volume in which a tappet **159** is housed. The tappet is herein defined as a piercing member of a substantially hard material such as plastics having a sort of spike **156** protruding out from a supporting portion **157** of the tappet.

The tappet **159** is arranged inside the above mentioned conical hollow volume so that the tappet **159** normally holds on the cup port **56a** by means of the spike **156**, as shown in Figure 13.

In the preferred embodiment, the supporting portion **157** of the tappet is a disc extending throughout the bottom surface of the dose of ground coffee, which disc comprises a plurality of through holes **55** evenly distributed on its top surface. Furthermore, the bottom side of tappet **159** preferably comprises radial ribs **154**, **158**.

In the preferred embodiment depicted in Figure 15, the tappet **156** comprises surface grooves **155** running along a longitudinal direction from the tip end of the spike towards the bottom surface of the disc **157**, so that the spike **156** resembles the tip end of a Philips screwdriver. Obviously, this shape is only optional and other alternative shapes can be provided for the spike **156**, as long as these shapes allow the tappet to pierce the base **57** of the capsule.

At the beginning of the beverage extraction phase, when the filter holder is inserted into the bayonet holder, a mechanical pressure is applied to the base **57**, which tends to warp towards the tappet. As a consequence, the cup port **56a** is pierced by the spike **156** and an outlet for the extracted beverage is thus automatically created. A gap for conveying the extracted

beverage to the outside is maintained by the ribs **154**, **158** and by the grooves **155**.

The lid port **56b** is instead pierced by the injection nozzle of the extraction machine and the injected water is spread over the top surface of  
5 the ground coffee by means of the surface shape of the lid portion **53**.

The capsule **51** is preferably manufactured by thermoforming, starting from a film or sheet of polylaminate thermoplastic or thermoset plastic materials, for instance a multilayer sheet comprising PE, PET and PVDC. With this manufacturing technique, the resulting capsule is very light  
10 and handy and uses a modest amount of packaging materials, too.

It is thus seen that even capsule **51** integrates most of features of standard extraction chambers and, as well as the other cartridges according to the invention, it ensures an air-tight preservation of the ground coffee.

Moreover, during the extraction phase, a spout is automatically  
15 formed at the cup port **56a**, by means of which the extracted beverage is delivered directly to an external drinking cup or glass without contaminating the cartridge or filter holder.

Various embodiments of the cartridge according to the invention have been described hereinabove. According to a second aspect of the  
20 invention, an extraction assembly for application to standard espresso coffee machine or to another machine which can pump hot water or other infusion fluids under pressure for producing beverages will be now described in detail.

With reference to Figures 16-18, an extraction assembly **60** according  
25 to a preferred embodiment of the invention comprises a support connectable to an espresso coffee machine, which is preferably composed of a connector member **62**, for connecting the extraction assembly to the water injection tube of the beverage extraction machine, and a bayonet holder **63**.

The connector member **62** has a base and a cylindrical sidewall  
30 raising from the base and ending with a flanged rim that serves for mounting

the support on the extraction machine (not shown), for instance by using screws. The base of the connector member 62 comprises a protruding inlet port 65 connectable to the water outlet of the extraction machine and, on the opposite side of the base, a circular guiding wall 259, which is described 5 hereinafter.

The bayonet holder 63 has a substantially cylindrical shape and comprises an upper open end into which the cylindrical sidewall of connector member 62 fits. Preferably, the bayonet holder 63 is fixed to the connector member 62 by means of the same screws used for mounting the 10 connector member to the extraction machine. Obviously, the bayonet holder and the connector member may be reciprocally fixed in any other known way; for instance, the outer surface of the cylindrical sidewall of the connector member and the upper inner surface of the cylindrical sidewall of the bayonet holder may be threaded. Alternatively, the connector member 15 and the bayonet holder may be built as a single piece.

The bayonet holder 63 further comprises a bottom open end on which guides 263 of a known kind are provided for bayonet fitting with a cartridge holder 64, which is provided with a grip handle 61.

The cartridge holder 64 comprises a substantially cylindrical body 20 that is internally shaped so as to completely house the cartridge 21. In particular, it comprises a cylindrical sidewall that is complementary to the sidewall 28 of the cartridge.

Moreover, the base of the cartridge holder 64 comprises an annular groove 261, into which the flange 125a of the cartridge fits slidingly, and a 25 bottom 250, which is located inside the cylindrical body of the cartridge holder and comprises an opening 267 at its central region.

The depth of the annular groove 261 is substantially equal to the height of the flange 125a, so that when cartridge 21 is inserted into the cartridge holder 64, the surface of the base 27 leans almost completely 30 against the bottom 250 and the cup port 26a protrudes from the opening 267.

Therefore, the internal shape of the cartridge holder **64** substantially corresponds to the external shape of the cartridge **21**, thus assuring a tight fit of the cartridge within the holder.

The extraction assembly **60** further comprises an injection nozzle assembly **265a**, **265b** that is firmly mounted on the bottom open end of the inlet **65** facing the cartridge holder, for instance by a thread fitting. Alternatively, the nozzle assembly and the water inlet port **65** may be made in a single piece.

With reference to Figures 21 and 22, the nozzle assembly comprises a hollow nozzle body **265a** and a piercing member or needle **265b** fixedly mounted to the inner surface of the nozzle body. More in detail, the nozzle body is substantially tubular and comprises two open ends **251** and **254**.

The open end **254** is located at the bottom end of the nozzle body and it is wide enough to receive a projecting lid port of a cartridge according to the invention, for instance lid port **26b**.

The open end **251** is defined at the upper end of the nozzle body by the wall **253**, which is shaped so as to tightly fit with the inner surface of the bottom open end of the inlet **65**. The external surface of the upper wall **253** and the internal surface of the inlet **65** may be threaded so as to secure the nozzle body to the connector member **62**. Alternative arrangements for coupling the nozzle assembly to the inlet of the connector member may be also provided, as long as a fluid tight fit is guaranteed between them.

The external surface of the nozzle body **265a** comprises a radially protruding stepped portion **257** for limiting the axial displacement of a cartridge ejector **269**, as described below. The internal surface of nozzle body **265a**, instead, comprises an annular projection **252** that extends inwardly and which is preferably located in a middle region of the internal surface of the nozzle body.

The needle **265b** is axially inserted and secured in the opening defined by annular projection **252**. In order to allow passage of fluid from

the upper open end **251** to the bottom open end **254**, through openings **256** are provided in the annular projection **252**.

The internal surface of the nozzle body **265a** further comprises an annular recess **255**, which is located in a bottom region of the same internal surface, preferably around the bottom open end **254**. Such recess houses an O-ring **266**, which acts as a means for providing a radial fluid-tight seal between the nozzle assembly and the inlet port **26b** of the cartridge **21** during the beverage extraction phase.

A great advantage brought about by the O-ring **266** is that it prevents the injected water from contaminating any internal component or surface of the extraction assembly **60** and from lapping the outer surface of the cartridge, which has to be touched and handled by the user. Accordingly, superior hygienic conditions are guaranteed and the extraction machine can be used hundreds of times without having to clean the components of the extraction assembly, such as the cartridge holder **64** and the support **62, 63**.

Such a contamination-free arrangement also advantageously combines with the integration of an outlet spout in the cartridge according to the invention. The same beverage extraction machine and the same extraction assembly can be consecutively used for cartridges containing different edible substances, such as coffee, chocolate, tea or herbal infusions, soups, other hot milk beverages, without incorporating the main disadvantage of common systems that contaminate and negatively influence the extraction results of consecutive beverage extractions.

Moreover, the resilient nature of the O-ring **266** allows to use various cartridges having inlet ports of different radial sizes, as long as these radial sized do not exceed the average diameter of the bottom opening **254** of the nozzle assembly.

In order to enhance the practicality of the extraction assembly, a cartridge ejector **269** is mounted in the annular space defined by the guiding wall **259** and the portion of the nozzle body **265a** protruding out of the water

inlet **65**. The cartridge ejector **269** is substantially toroidal and is preferably shaped so as to fit into the annular space defined by the guiding wall **259**, the base of connector member **62**, the lid portion of the cartridge and the portion of nozzle body **265a** protruding out of the water inlet **65** during the  
5 extraction phase.

The cartridge ejector **269** comprises a plurality of springs **268** located in respective hollow housings having an open end from which the springs can extend. The springs **268** abut against the base of the connector member **62** and against respective abutment surfaces provided inside the hollow  
10 housings of the cartridge ejector.

When the cartridge holder **64** is fixed to the bayonet holder **63**, the ejector **269** is pushed towards the base of the connector member **62** and the springs **268** are compressed. As it is seen in Figure 18, in this position the lid port **26b** is pierced by the needle **265b** and water can be injected inside the  
15 cartridge as described above.

As soon as the cartridge holder is removed, the ejector **269** keeps the cartridge **21** inside the cartridge holder **64**, as it is seen from Figure 20. In order to stop the ejector's travel when the cartridge holder is released, an annular projection **258** is provided around the internal surface of the toroidal  
20 body of the cartridge ejector, which abuts against the stepped portion **257** of the nozzle body **265a** when the ejector slides downwardly towards the cartridge holder.

While a particular embodiment of an extraction assembly for an espresso coffee machine has been described with reference to a cartridge of  
25 the kind shown in Figure 6, it is understood that any equivalent extraction assembly can be provided that is particularly suited for any cartridge according to the invention.

For instance, with reference to Figure 19, a particular extraction assembly **70** suited for a discoidal cartridge **71** according to the invention  
30 can be designed, according to the above teachings.

The discoidal cartridge **71** has not been described in detail so far, but it is immediately derivable by combining features of embodiments of the cartridge according to the invention which have already been described in detail. This combination is hereby presented to show that elements from 5 different embodiments may be combined to obtain further embodiments that clearly fall under the same inventive concept and which are clearly in the reach of the skilled in the art.

The cartridge **71** incorporates features of cartridges **11**, **31** and **41**. In detail, it has a general discoidal shape and houses a coffee tablet of a known 10 kind, as cartridge **31**. The cup portion of cartridge **71** is similar to the cup portion **37**, but comprises a shim **119** and a rubber valve or pad **116** of the kind used in cartridge **11**; the pad **116** is depicted in a deformed condition, which is reached during the extraction phase. Differently from cartridge **31**, the lid port only slightly protrudes with respect to the lid portion and it is 15 closed by a rubber plug or seal **78**, identical to the plug **48** used in cartridge **41**.

Accordingly, the extraction assembly **70** comprises a support connectable to an espresso coffee machine, which is preferably composed of a connector member **72**, for connecting the extraction assembly to the water 20 injection tube of the beverage extraction machine, and a bayonet holder **73**.

The connector member **72** comprises a water inlet port **75**, for connection to a water injection port of a beverage extraction machine, and a annular wall **359** protruding towards the internal volume of the bayonet holder **73** when this is mounted on the connector member.

25 The bayonet holder **73** has a substantially cylindrical shape and comprises an upper open end into which the annular wall **359** of the connector member **72** fits. Preferably, the bayonet holder **73** is fixed to the connector member **72** by means of the same screws used for mounting the connector member to the extraction machine. Obviously, the bayonet holder 30 and the connector member may be reciprocally fixed in any other known

way; for instance, the outer surface of the cylindrical sidewall of the connector member and the upper inner surface of the cylindrical sidewall of the bayonet holder may be threaded. Alternatively, the connector member and the bayonet holder may be built in a single piece.

5        The bayonet holder 73 further comprises a bottom open end on which guides 263 of a known kind are provided for bayonet fitting with a cartridge holder 74.

The cartridge holder 74 comprises a substantially flattened body whose internal shape is complementary to the cup portion of cartridge 71.  
10      Moreover, the base of the cartridge holder 74 comprises an opening 377 at its central region through which a cup port 76a of cartridge 71 is arranged.

When the cartridge holder 74 is firmly secured to the bayonet holder 73, the peripheral flat rim 79 of cartridge 71 is tightly kept between the annular wall 359 and the rim of cartridge holder 74.

15      The extraction assembly further comprises a nozzle 275 that is secured to the inlet port 75 and that protrudes towards the cartridge holder.

Referring to Figure 23, the nozzle 275 is a substantially cylindrical hollow piece having an inner axial cavity 359 for receiving water from the water inlet 75 and having a needle or piercing member 358 integrated  
20      therein. The cavity 359 extends as far as the needle, which is axially hollow and comprises radial through openings 356 for supplying water in a substantially radial direction.

An annular recess 355 is further provided in the nozzle 275, in particular around the needle 358. The recess 355 is shaped so as to receive  
25      the thicker peripheral portion of the plug 78 as soon as the cartridge holder 74 is secured to the bayonet holder 73. As it is noted from Figure 19, in this position the plug 78 is pierced by the needle 358, so that water can be injected inside the cartridge, and the plug 78 provides for a fluid-tight seal between the nozzle 275 and the lid port of cartridge 71.

30      Therefore, the plug 78 acts as a means for providing radial fluid-tight

seal between the water inlet port of the extraction assembly and the cartridge, thus preventing the injected water from lapping the external surface of the cartridge.

Advantageously, the extraction assembly 70 comprises a cartridge 5 ejector 369 that is housed in the annular space defined by the wall 359 and the nozzle 275 and that is similar to the ejector 269.

When the cartridge holder 74 is fixed to the bayonet holder 73, the ejector 369 is pushed upwardly towards the connector member 72 by means of springs 368, which are accordingly compressed. Instead, when the 10 cartridge holder 74 is removed from the bayonet holder 73, the ejector 269 keeps the cartridge 71 inside the cartridge holder 74. In order to stop the ejector's travel when the cartridge holder is released, an annular projection 378 is provided around the internal surface of the toroidal body of the cartridge ejector 369, which abuts against the stepped portion 357 of the 15 nozzle body 275 when the ejector slides downwards towards the cartridge holder.

With reference to Figures 24-26, an extraction assembly 80 according to yet another embodiment of the invention comprises a support connectable to an espresso coffee machine, which is preferably composed of a connector 20 member 82, for connecting the extraction assembly to the water injection tube of the beverage extraction machine, and a bayonet holder 83.

The connector member 82 has a base and a cylindrical sidewall raising from the base and ending with a flanged rim that serves for mounting the support on the extraction machine (not shown), for instance by using 25 screws. The base of the connector member 82 comprises a protruding inlet port 85 connectable to the water outlet of the extraction machine and, on the opposite side of the base, a circular guiding wall 459. It is seen that the connector member 82 is substantially similar to the previously described connector member 62.

30 The bayonet holder 83 has a substantially cylindrical shape and

comprises an upper open end into which the cylindrical sidewall of connector member 82 fits. Preferably, the bayonet holder 83 is fixed to the connector member 82 by means of the same screws used for mounting the connector member to the extraction machine. Obviously, the bayonet holder 5 and the connector member may be reciprocally fixed in any other known way. For instance, the outer surface of the cylindrical sidewall of the connector member and the upper inner surface of the cylindrical sidewall of the bayonet holder may be threaded. Alternatively, the connector member and the bayonet holder may be built as a single piece.

10 Moreover, the bayonet holder 83 comprises a bottom open end on which guides of a known kind are provided for bayonet fitting with a cartridge holder 84.

In order to deliver water inside the cartridge 51, a nozzle 285 is secured to the inlet port 85 and protrudes towards the cartridge holder 84.

15 Referring to Figure 26, the nozzle 285 is a substantially cylindrical hollow piece in which an inner axial cavity 459 is formed for receiving water from the water inlet 85. A hollow needle or piercing member 458 is integrated with the nozzle 285 so that the cavity 459 extends as far as the needle. Advantageously, the needle 458 comprises radial through openings 20 456 for supplying water in a substantially radial direction.

An annular recess 455 is further provided in the nozzle 285, in particular around the needle 458, for housing an O-ring 466, which acts as a means for providing a radial fluid-tight seal between the nozzle assembly and the inlet port 56b of the cartridge 51 during the beverage extraction 25 phase.

Advantageously, the extraction assembly 80 comprises a cartridge ejector 469 that is housed in the annular space defined by the wall 459 and the nozzle 285 and that is similar to the ejector 269.

The ejector 469 preferably comprises a peripheral annular rib 470 on 30 its bottom side, which is shaped so as to engage the peripheral bulge 151a of

the lid portion of cartridge **51** when the cartridge holder is secured to the bayonet holder.

The cartridge holder **84** has a substantially cylindrical body that is internally shaped so as to house capsule **51**. In particular, it comprises an inner sidewall that is shaped substantially complementary to the sidewall of the capsule and that ends with an annular shoulder **86** in an upper region and with an opening **477** in a bottom region of the capsule holder.

The base of the cartridge holder **84** has not the same slope of the base **57** of capsule **51**. Preferably, the base region of the capsule holder **84** slopes substantially parallel to the ribs **154** and **158** of the tappet **159**. Accordingly, in an initial condition in which the cartridge holder is not completely secured to the bayonet holder, the capsule **51** supports itself on the contour of the opening **477** only in correspondence of the region around the cup port **56a** and the flanges **59a**, **59b** are in a raised position with respect to the annular shoulder **86** of the cartridge holder **84**.

As soon as the cartridge holder **84** is manually rotated for securing it to the bayonet holder **83**, the lid portion of the capsule **51** firstly abuts against the bottom surface of the ejector **469** and then abuts against the annular wall **459**. Accordingly, a pressure is applied to the base **57** that causes the spike **156** to pierce the cup port **56a** and the base **57** to buckle against the bottom side of tappet **159**.

In the final position, that is to say in the position shown in Figure 25 in which the capsule holder **84** is fully secured to the bayonet holder **83** and the system is ready for the beverage extraction phase, the cup port **56a** is fully opened and the extracted beverage can be supplied directly in an external cup.

Figure 25 also shows that, in the beverage extraction position, the nozzle **285** has pierced the inlet port **56b** of capsule **51**. The M-like shape of the inlet port **56b** advantageously provides for an easy engagement with the needle portion of the nozzle **285**.

Advantageously, as soon as the capsule holder **84** is removed from the bayonet holder, the ejector **469** keeps cartridge **51** inside the cartridge holder **84**. In order to stop the ejector's travel when the cartridge holder is released, an annular projection **478** is provided around the internal surface of 5 the toroidal body of the cartridge ejector, which stops against an abutment **57** of the nozzle body **285** when the ejector slides downwards.

The above extraction assemblies comprise an injection nozzle that is provided with a needle for breaking the plug or seal of the upper port of the cartridge and for accessing the internal volume of the cartridge. Moreover, 10 the upper ports of the above cartridges are sized so as to be insertable into a corresponding female nozzle. However, it is possible to provide an opposite coupling between the injection nozzle and the upper port of a cartridge without departing from the scope of the present invention. For instance, with reference to Figure 28, an extraction assembly according to another 15 embodiment of the invention comprises a support connectable to an espresso coffee machine, which is preferably composed of a connector member **582**, for connecting the extraction assembly to the water injection tube of the beverage extraction machine, and a bayonet holder **583**.

The connector member **582** has a base and a cylindrical sidewall 20 raising from the base and ending with a flanged rim that serves for mounting the support on the extraction machine (not shown), for instance by using screws. The base of the connector member **582** comprises a protruding inlet port **585** connectable to the water outlet of the extraction machine and, on the opposite side of the base, a circular guiding wall **559**.

25 The bayonet holder **583** has a substantially cylindrical shape and comprises an upper open end into which the connector member **582** fits. Preferably, the bayonet holder **583** is fixed to the connector member **582** by means of the same screws used for mounting the connector member to the extraction machine, as in the embodiments described here above. Obviously, 30 the bayonet holder and the connector member may be reciprocally fixed in

any other known way; for instance, the outer surface of the cylindrical sidewall of the connector member and the upper inner surface of the cylindrical sidewall of the bayonet holder may be threaded. Alternatively, the connector member and the bayonet holder may be built as a single piece.

5       The bayonet holder **583** further comprises a bottom open end on which guides of a known kind are provided for bayonet fitting with a cartridge holder **584**.

10      The cartridge holder **584** comprises a substantially cylindrical body that is internally shaped so as to completely house the above described cartridge **81**. In particular, it comprises a cylindrical inner sidewall that is complementary to the sidewall of the cartridge.

15      Moreover, the base of the cartridge holder **584** comprises an annular groove **561** into which the lower flange of the cartridge **81** fits slidingly, and a bottom **550** that is located inside the cylindrical body of the cartridge holder and that comprises an opening **567** at its central region. The annular groove **561** and the bottom **550** are shaped so that when the cartridge **81** is inserted into the cartridge holder **584**, the surface of its base **87a** leans almost completely against the bottom **550** and the cup port **86a** protrudes from the opening **567**.

20      The extraction assembly of Figure 28 further comprises an injection nozzle **575** that is firmly mounted on the bottom open end of the inlet **585** facing the cartridge holder, for instance by a thread fitting. Alternatively, the nozzle assembly and the water inlet port **585** may be made in a single piece.

25      The nozzle **575** comprises a hollow cylindrical body with opposite open ends and comprises a flange **557** in a middle region thereof.

30      A hollow tip end **558** of a substantially cylindrical shape protrudes axially from the flange **557** of the nozzle towards the cartridge holder and it is shaped so as to have an external diameter that is generally smaller than the inner diameter of the lid port **86b**. Accordingly, the tip end **558** can be completely inserted into the lid port when the cartridge holder **584** is fixedly

mounted on the bayonet holder 583, thanks to the appositely wide lid port 56b.

The tip end 558 is substantially wider than a (common) injection needle, but it is small enough to be insertable as a male part into a cartridge 5 port such as the lid port 86b. Advantageously, the tip end 558 comprises an annular recess formed around its external surface, for housing a sealing means such as an O-ring 566.

Advantageously, the extraction assembly comprises a toroidal cartridge ejector 569, which is housed in the annular space defined by the 10 wall 559 of the connector member and the nozzle 575 and which is similar to the other cartridge ejectors described here above.

The axial travel of the ejector 569 is limited by means of common snap-brackets 578, which extend upwardly and which are slidingly inserted into an appropriate annular recess 579 surrounding the nozzle 575. The limit 15 stop for the snap-brackets 578 is defined by the flange 557 of the nozzle 575.

Advantageously, the toroidal cartridge ejector 569 comprises an inner concentric sidewall 568 that is sized so as to define an annular gap between the tip end 558 of the injection nozzle, which gap is completely filled with the sidewall of the lid port 86b when the cartridge 81 is mounted into the 20 extraction assembly. Therefore, in the particular arrangement depicted in Figure 28, the cartridge ejector acts also as a retaining wall against a possible expansion of the lid port during the extraction phase.

The extraction assembly of Figure 28 benefits of a simple arrangement that eliminates piercing needles and, at the same time, 25 guarantees a contamination-free coupling between the cartridge, the extraction chamber and the water injection chamber. In fact, regardless of whether the lid port is closed or not before installing it into the extraction assembly, the injection nozzle acts as a male part and the lid port as a female part, and the injection nozzle can pierce the upper seal, if any, of the lid port 30 without the need of an appropriate needle.

The injection portion **575**, **585** of the extraction assembly is kept insulated from the extraction chamber defined by the cartridge by means of an external O-ring, and a very high number of consecutive extraction processes of the same or different beverages can be carried out without 5 cleaning or servicing in any way the extraction assembly.

Moreover, the external O-ring **566** of the injection nozzle can be easily replaced or serviced without having to access internal parts of the injection nozzle itself.

It has thus been shown that the present invention fulfils the proposed 10 aim and objects. Clearly, several modifications to either the cartridges and the extraction assemblies according to the invention will be apparent to and can be readily made by the skilled in the art without departing from the scope of the present invention. Therefore, the scope of the claims shall not be limited by the illustrations or the preferred embodiments given in the 15 description in the form of examples, but rather the claims shall encompass all of the features of patentable novelty that reside in the present invention, including all the features that would be treated as equivalents by the skilled in the art.

The disclosures in European Patent Applications 04007293.6 - 20 04007294.4 - 04007295.1 - 04007296.9 from which this application claims priority are incorporated herein by reference.